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Two New Caridean Shrimps of the Family Alvinocarididae (Crustacea, Decapoda) from a Hydrothermal Field at the Minami-Ensei Knoll in the Mid-Okinawa Trough, Japan

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Seventy-two specimens representing two new species of *Alvinocaris* of the family Alvinocarididae, *A. brevitelsonis* and *A. leurokolos*, were found in samples collected from thermally influenced fields at the Minami-Ensei Knoll (28°23.35'N, 127°38.38'E, 705 m depth). The shrimps appeared to be the co-dominant macroinvertebrates in the small hollows of chimneys and among the mussel beds, bathing directly in vent fluids in the high temperature hydrothermal field. A key to the seven known species of *Alvinocaris* is given.

Key Words: *Alvinocaris*, new species, hydrothermal vent, Minami-Ensei Knoll, *Shinkai 2000*.

The genus *Alvinocaris* was described as a new genus of the family Bresiliidae by Williams and Chase (1982) for *Alvinocaris lusca* collected from the thermally influenced fields of the Galapagos Rift. Christoffersen (1986) moved this genus to his newly established family Alvinocarididae. Since then, four species (*A. markensis* Williams, 1988, *A. muricola* Williams, 1988, *A. stactophila* Williams, 1988, and *A. longirostris* Kikuchi and Ohta, 1995) have been described from the North Atlantic Ridge and from the Gulf of Mexico (Williams 1988) and from the Ryukyu Islands, Japan (Kikuchi and Ohta 1995).

During the course of biogeographical and ecological surveys of the hydrothermal vent communities at the Minami-Ensei Knoll in the Mid-Okinawa Trough by the Japanese submersible *Shinkai 2000* (Hashimoto et al. 1995), 72 specimens representing two species of shrimps belonging to the genus *Alvinocaris* were collected. In the present paper the two species are described as new: *Alvinocaris brevitelsonis* and *A. leurokolos*. A key is also presented for all the known species of the genus.

Table 1. Dive record of the *Shinkai 2000* at Depression C of the Minami-Ensei Knoll.

Dive number	Date	Location	Depth (m)
547	3 June 1991	28°23.35'N, 127°38.38'E	700-711
549	5 June 1991	28°23.35'N, 127°38.38'E	694-706

Materials and Methods

Samples were collected in the so-called "Depression C" on the Minami-Ensei Knoll, which is located approximately 140 km west of Amami-Oshima Island, during dives 547 and 549 of the *Shinkai 2000* in 1991. The knoll is situated in the northern part of the central graben of the Mid-Okinawa Trough, referred to as the Torishima Central Graben. Many small knolls and several depressions are scattered to the south of the Minami-Ensei Knoll. The sampling site was in a thermally influenced area; the depth was about 700 m. Shrimps examined in this study were obtained with a suction sampler (Hashimoto *et al.* 1992, 1995); sampling data are summarized in Table 1. Samples were sorted, sexed, and measured. Carapace length (CL; measured from the orbital margin to the posteromedian margin of the carapace) was used as an indicator of size. The samples were preserved in 10% buffered formalin sea-water solution and then transferred and preserved in 70% ethanol. Drawings were made with the aid of a camera lucida.

The type materials are deposited in the National Science Museum, Tokyo (NSMT), and the remaining specimens are deposited in the Marine Ecosystems Research Department, JAMSTEC.

Systematics

Family **Alvinocarididae** Christoffersen, 1986

Genus **Alvinocaris** Williams and Chace, 1982

***Alvinocaris brevitelsonis* sp. nov.**

(Figs 1-3)

Materials. Ten specimens collected by the deep-sea submersible *Shinkai 2000* during dive 547 in Depression C of the Minami-Ensei Knoll, 28°23.35'N, 127°38.38'E, 705 m; 3 June 1991; 8♂♂ (CL: 4.4, 4.6, 6.4, 6.7, 6.9, 7.2, 8.4, 8.5), 2♀♀ (CL: 9.7, 10.3).

Types. Holotype: (NSMT-Cr 12454), adult female of 10.3 mm CL. Allotype: (NSMT-Cr 12455), adult male of 7.2 mm CL. Paratypes: (NSMT-Cr 12456), 1 adult male of 6.9 mm CL and 1 adult female of 9.7 mm CL. Types all from *Shinkai 2000* dive 547.

Description. Integument thin and membranous. Rostrum (Fig. 1a) slightly curved upward, reaching distal margin of second segment of antennular peduncle; dorsal margin armed with 8 spines; lateral carinae broadened proximally and confluent with orbital margin of carapace; ventral margin less prominent than dorsal and armed with 7 spines. Carapace with 5 dorsal spines confluent with rostral series, posteriormost about one half as far from orbit as from posterior margin; an-

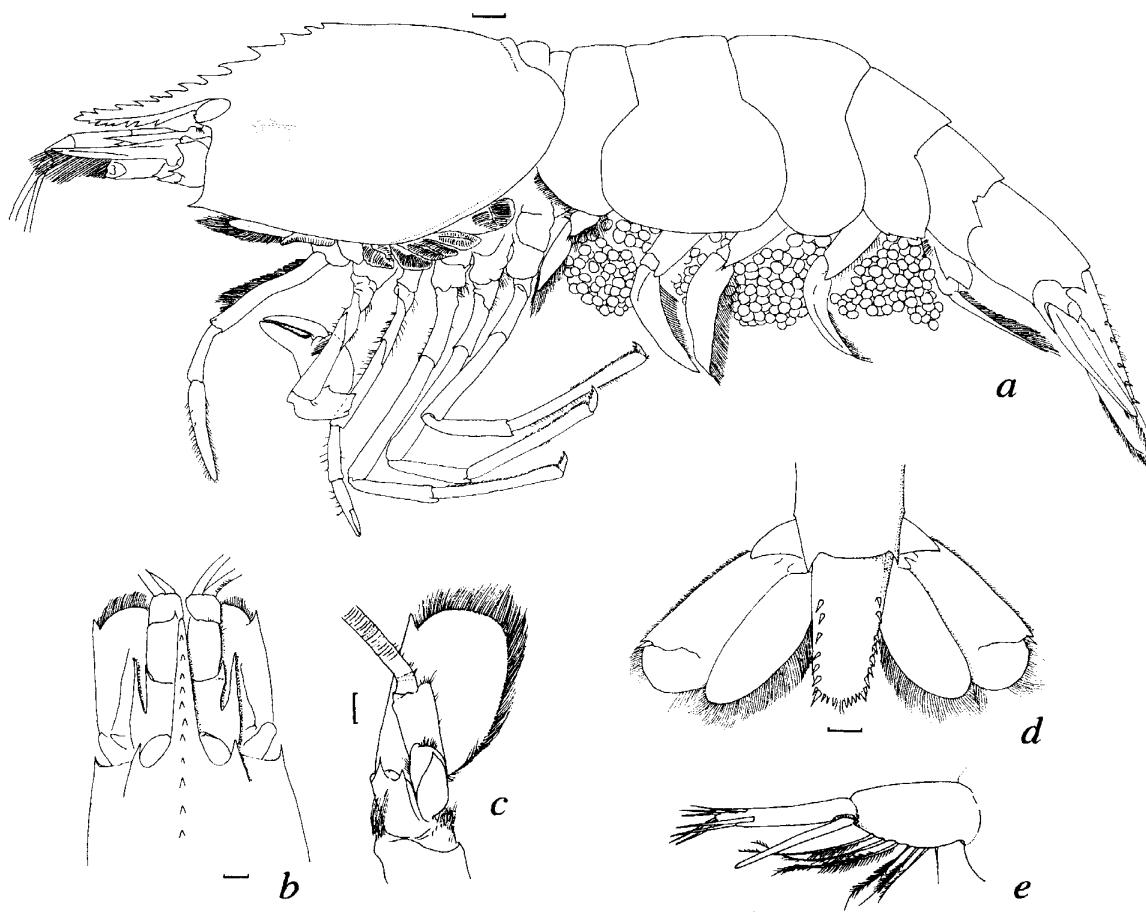


Fig. 1. *Alvinocaris brevitelsonis* sp. nov.: a, holotype female in lateral aspect; b, anterior region (dorsal aspect) of holotype; c, right antennal scale (ventral aspect) of holotype; d, telson and uropods (dorsal aspect) of holotype; e, appendix masculina and appendix interna of male allotype. Scale bars 1.0 mm.

tennial spine distinct; antennal groove indistinct; pterygostomial spine acute and prominent.

Abdomen (Fig. 1a) with pleura of anterior 3 somites broadly rounded; ventral margin of fourth pleuron with 2 spines; sixth somite about 1.6 times as long as fifth. Telson (Fig. 1d) moderately wide, tapering to slightly convex posterior margin, with two longitudinal rows of dorsal submarginal spines, length about 2.0 times proximal width, 2.9 times distal width; posterior margin armed with 9 teeth and a few setae.

Eye (Fig. 1b) with cornea globular, unfaceted, and unpigmented, anterior surface bearing 1 small, spinelike tubercle slightly exceeding antennal spine.

Antennal peduncle (Fig. 1b) reaching beyond distal margin of antennal scale; stylocerite tapering to slender and elongate tip, reaching to 0.3 of second peduncular segment; first segment 1.6 times as long as second and 3.0 times as long as third, measured along mesial margin.

Antennal scale (Fig. 1c) about 2 times as long as wide, distolateral tooth fairly strong, falling short of broadly rounded distal margin of blade. Carpocerite reach-

ing to about midlength of scale; basal segment with 1 or 2 strong distolateral spines.

Mandible (Fig. 2a) with 2-jointed palp, incisor process bearing 9 marginal teeth, molar process slender, divergent.

First maxilla (Fig. 2b) with coxal endite semitriangular, mesial margin bearing many setae; basal endite broadened mesially, armed with many short spines on mesial margin; endopod with long, plumose setae on distomesial corner and 2 submarginal, short spines on distal portion.

Second maxilla (Fig. 2c) with proximal endite represented by 2 lobes; distal endite subtriangular, expanded mesiodistally and paralleled laterally by narrow, slightly twisted and tapering endopod; endopod with sparse setae on mesial margin. Scaphognathite with anterior lobe rounded and broadened, fringed with long, silky setae on anterior and anteromesial margins, lateral margin with shorter setae; posterior lobe triangular, with extremely long setae on posteromedian margin.

First maxilliped (Fig. 2d) with very large leaflike exopod; basal endite about half as long as exopod, coxal endite small, half length of basal endite; epipod obscurely bilobed.

Second maxilliped (Fig. 2e) with very long ischium about 4 times as long as merus; exopod not reaching articulation between ischium and merus; epipod subtriangular, lacking podobranch.

Third maxilliped (Fig. 2f) long and setose, exceeding end of antennal scale; dactylus tapered distally with 3 terminal spines; mesial surface of dactylus and distal half of propodus with dense setae, distal margin of carpus with 1 acute spine, exopod reduced to fingerlike projection.

First pereopod (Fig. 2g) robust and chelate, fingers curved downward and inward; propodus about 2.2 times longer than dactylus; cutting edge with row of uniform teeth set side-by-side; carpus slightly shorter than palm, ventrolateral surface covered with carpal brush; merus and ischium without spines.

Second pereopod (Fig. 2h) slightly shorter than first pereopod, dactylus slightly shorter than palm, cutting edge pectinate with single row of small teeth, terminal claws strong; carpus about 2.2 times longer than dactylus; single spine on ventrolateral surface of ischium.

Third to fifth pereopods generally similar in length and structure, distal portion of carpus of each with liplike projection covering proximal portion of propodus. Third pereopod (Fig. 2i) with dactylus very short, armed with 3 strong spines on ventral or flexor margin; propodus about 7 times longer than dactylus, armed with scattered setae on flexor surface; carpus about 0.7 length of propodus; merus 1.1 times length of propodus, armed with 2 spines on ventrolateral margin; ischium about 0.4 length of merus, armed with 2 spines on ventral surface. Fourth pereopod (Fig. 2j) with dactylus armed with 3 strong spines on ventral or flexor margin, propodus about 10 times longer than dactylus, without spine; carpus about 0.6 length of propodus; merus about 2.6 times longer than ischium, armed with 2 spines on ventrolateral margin; ischium with 2 ventral spines. Fifth pereopod (Fig. 2k) with dactylus armed with 4 strong spines on ventral or flexor margin; propodus about 10 times longer than dactylus, without stout spine; carpus about 0.6 length of propodus; merus about 0.8 length of propodus, unarmed; ischium unarmed.

Two new species of *Alvinocaris*

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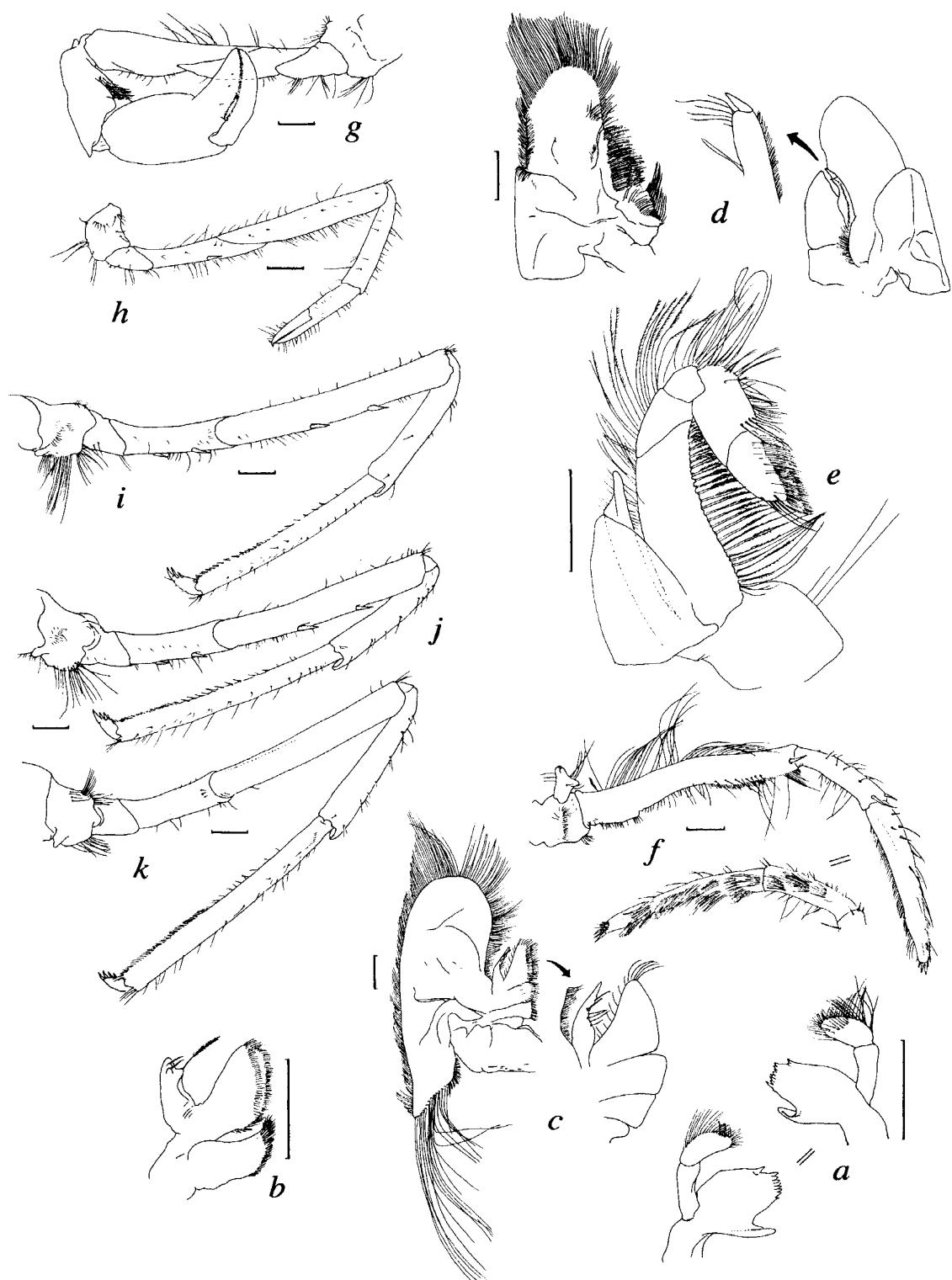


Fig. 2. *Alvinocaris brevitelsonis* sp. nov., female holotype: a, right mandible; b, right first maxilla; c, right second maxilla; d, right first maxilliped; e, right second maxilliped; f, right third maxilliped; g, right first pereopod; h, right second pereopod; i, right third pereopod; j, right fourth pereopod; k, right fifth pereopod. Scale bars 1.0 mm.

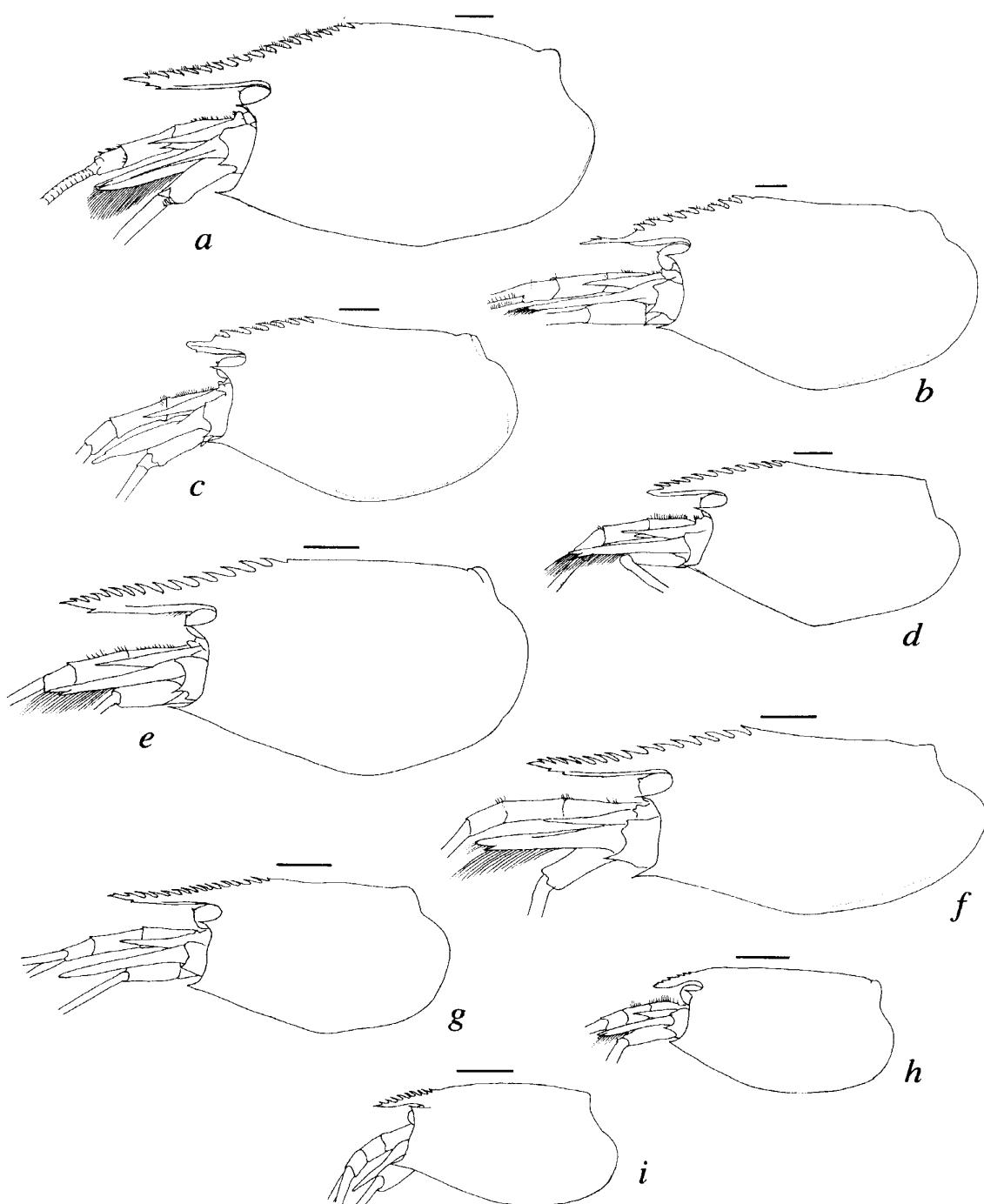


Fig. 3. *Alvinocaris brevitelsonis* sp. nov.: morphological variation (a-i) of cephalothorax in lateral aspect. Scale bars 1.0 mm.

Pleopods well developed. Appendix masculina of second pair of pleopods in male (allotype) armed with 7 slender spines extending beyond level of simple, slender appendix interna (Fig. 1e).

Uropods (Fig. 1d) with rami longer than telson, movable spine present on lateral ramus.

Color in life. Ivory to dull ivory white.

Variation. Morphological variations of the rostrum and anterior part of carapace are shown in Fig. 3a-i. Some adult (large) specimens (8.4-10.3 mm CL) have aberrant rostra, presumably due to injury (Fig. 3b, c), and/or shortened rostra (Fig. 3d). Young specimens (4.4-4.6 mm CL) have a shorter rostrum (Fig. 3h, i), which extends to the distal margin of the first segment of the antennular peduncle.

Etymology. The species name *brevitelsonis*, a genitive noun, is derived from the Latin for "short telson".

Remarks. Remarks are given in the account for *A. leurokolos*.

***Alvinocaris leurokolos* sp. nov.**
(Figs 4-7)

Materials. Sixty-two specimens collected by the deep-sea submersible *Shinkai 2000* during dive 549 in "Depression C" of the Minami-Ensei Knoll, 28°23.35'N, 127°38.38'E, 705 m; 5 June 1991; 8♂♂ (CL: 8.6, 8.7, 8.9, 9.4, 9.6, 10.0, 10.0, 11.5), 42♀♀ (CL: 6.2, 6.7, 6.8, 6.9, 7.1, 7.3, 7.5, 7.6, 7.6, 7.7, 7.7, 7.8, 7.9, 8.0, 8.2, 8.3, 8.4, 8.5, 8.6, 8.6, 8.7, 8.7, 8.8, 8.8, 8.9, 8.9, 9.0, 9.0, 9.1, 9.1, 9.1, 9.2, 9.3, 9.3, 9.4, 9.5, 9.6, 9.9, 10.1, 10.7, 12.5, 12.5), 12 juveniles (CL: 4.6, 4.7, 4.8, 4.9, 5.1, 5.2, 5.3, 5.3, 5.5, 5.8, 6.1, 6.1).

Types. Holotype: (NSMT-Cr 12457), adult female of 12.5 mm CL. Allotype: (NSMT-Cr 12458), adult male of 10.0 mm CL. Paratypes: (NSMT-Cr 12459), 2 adult males (10.0, 11.5 mm CL) and 2 adult females (9.2, 9.9 mm CL). Types all from *Shinkai 2000* dive 549.

Description. Integument thin, but not membranous. Rostrum (Fig. 4a) straight, reaching distal margin of first segment of antennular peduncle; dorsal margin armed with 9 teeth; lateral carinae broadened proximally and confluent with orbital margin of carapace; ventral margin without spines. Carapace with 2 dorsal spine confluent with rostral series, posteriormost spine about one-half as far from orbit as from posterior margin of carapace, antennal spine strong, extending outward slightly, distal part abruptly tapered to acute tip, without antennal groove; pterygostomial spine acuminate and prominent.

Abdomen (Fig. 4a) with pleura of anterior 3 somites broadly rounded; ventral margin of fourth pleuron with 1 spine; sixth somite about 1.6 times as long as fifth. Telson (Fig. 4d) moderately wide, tapering to slightly convex tip, length about 2.0 times proximal width, 3.6 times distal width; posterior margin slightly convex with fine setae.

Eye (Fig. 4b) with cornea globular, unfaceted, and unpigmented, anterior surface bearing with 1 small tubercle.

Antennular peduncle (Fig. 4b) reaching to distal margin of antennal scale; styligerous tapering to slender and elongate tip reaching to distal edge of second peduncular segment; first segment 1.5 times as long as second and 2.0 times as long as third, measured along mesial side.

Antennal scale (Fig. 4c) about 1.7 times as long as wide, distolateral tooth fairly strong, falling short of broadly rounded distal margin of blade. Carapocerite reaching to about midlength of scale; basal segment with 2 strong distolateral spines.

Mandible (Fig. 5a) with 2-jointed palp, incisor process bearing 7 marginal

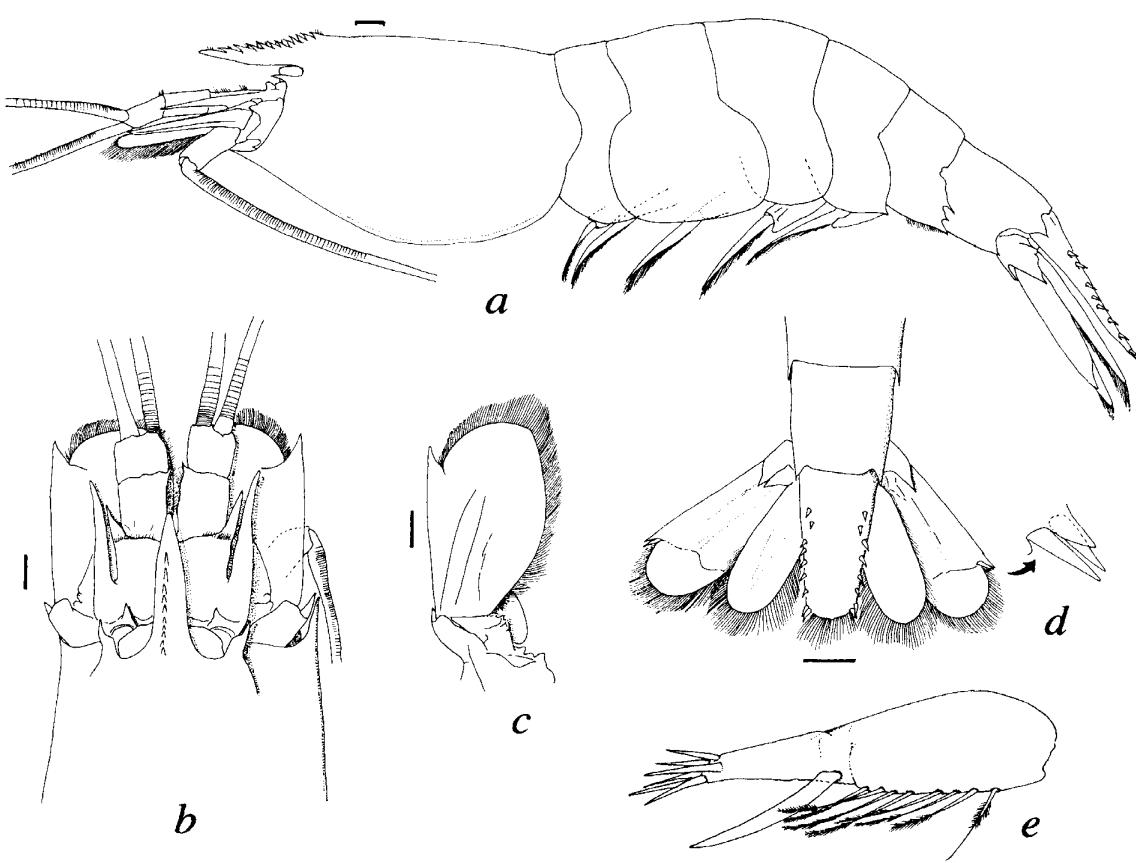


Fig. 4. *Alvinocaris leurokolos* sp. nov.: a, holotype female in lateral aspect; b, anterior region (dorsal aspect) of holotype; c, left antennal scale (dorsal aspect) of holotype; d, telson and uropods (dorsal aspect) of holotype; e, appendix masculina and appendix interna of male allotype. Scale bars 1.0 mm.

teeth, molar process slender, divergent.

First maxilla (Fig. 5b) with coxal endite semitriangular, mesial margin bearing many setae; basal endite broadened mesially, armed with many short spines on mesial margin, endopod with 1 long, plumose seta on distomesial corner and 1 submarginal, short spine on distal portion.

Second maxilla (Fig. 5c) with proximal endite represented by 2 lobes; distal endite subtriangular, expanded mesiodistally and paralleled laterally by narrow, slightly twisted and tapering endopods. Scaphognathite with anterior lobe rounded and broadened, fringed with long, silky setae on anterior and anteromedial margins; lateral margin with shorter setae; posterior lobe triangular, with extremely long setae on posteromedian margin.

First maxilliped (Fig. 6a) with large, leaflike exopod; basal endite about half as long as exopod; coxal endite small, about 0.6 length of basal endite; epipod obscurely bilobed; endopod 2-articulated, distal segment very short.

Second maxilliped (Fig. 6b) with ischium about 2.5 times as long as merus; exopod as long as ischium of endopod; epipod subtriangular, lacking podobranch.

Third maxilliped (Fig. 6c) setose, dactylus tapered distally with 2 strong terminal spines, mesial surface of dactylus with dense setae, distal margin of carpus

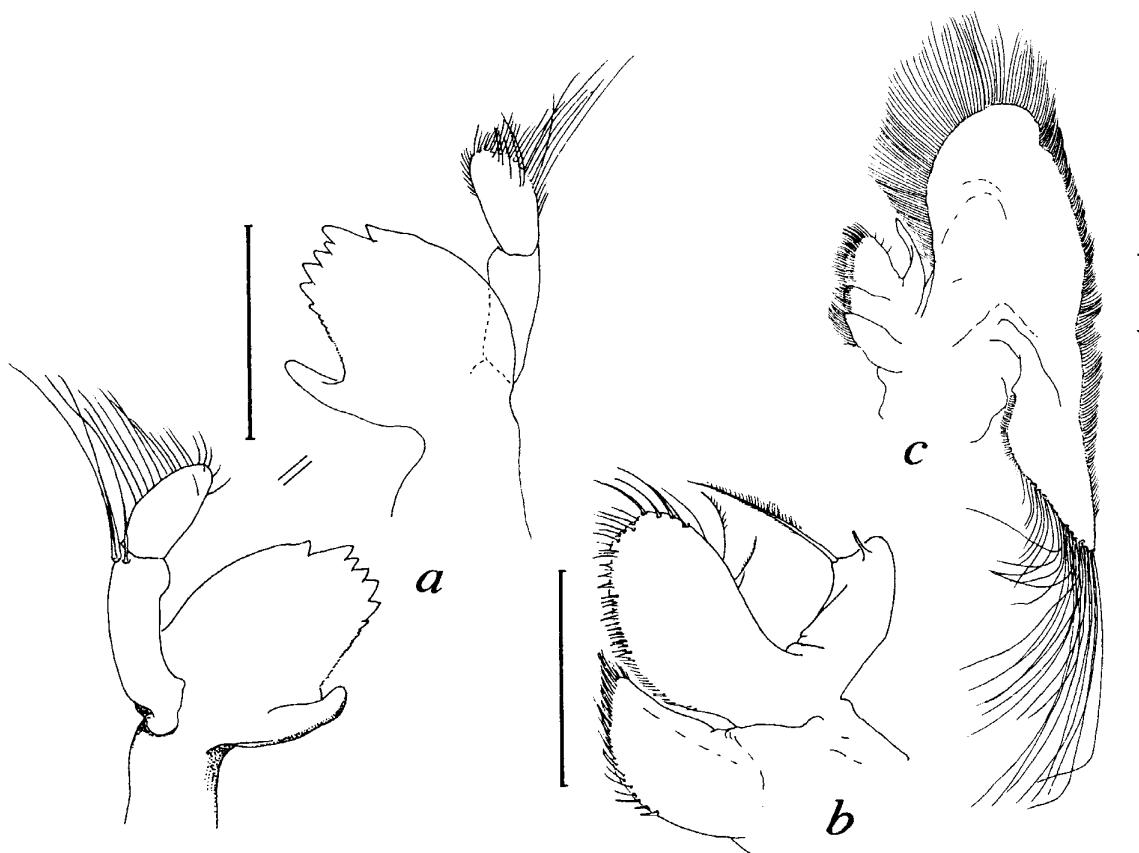


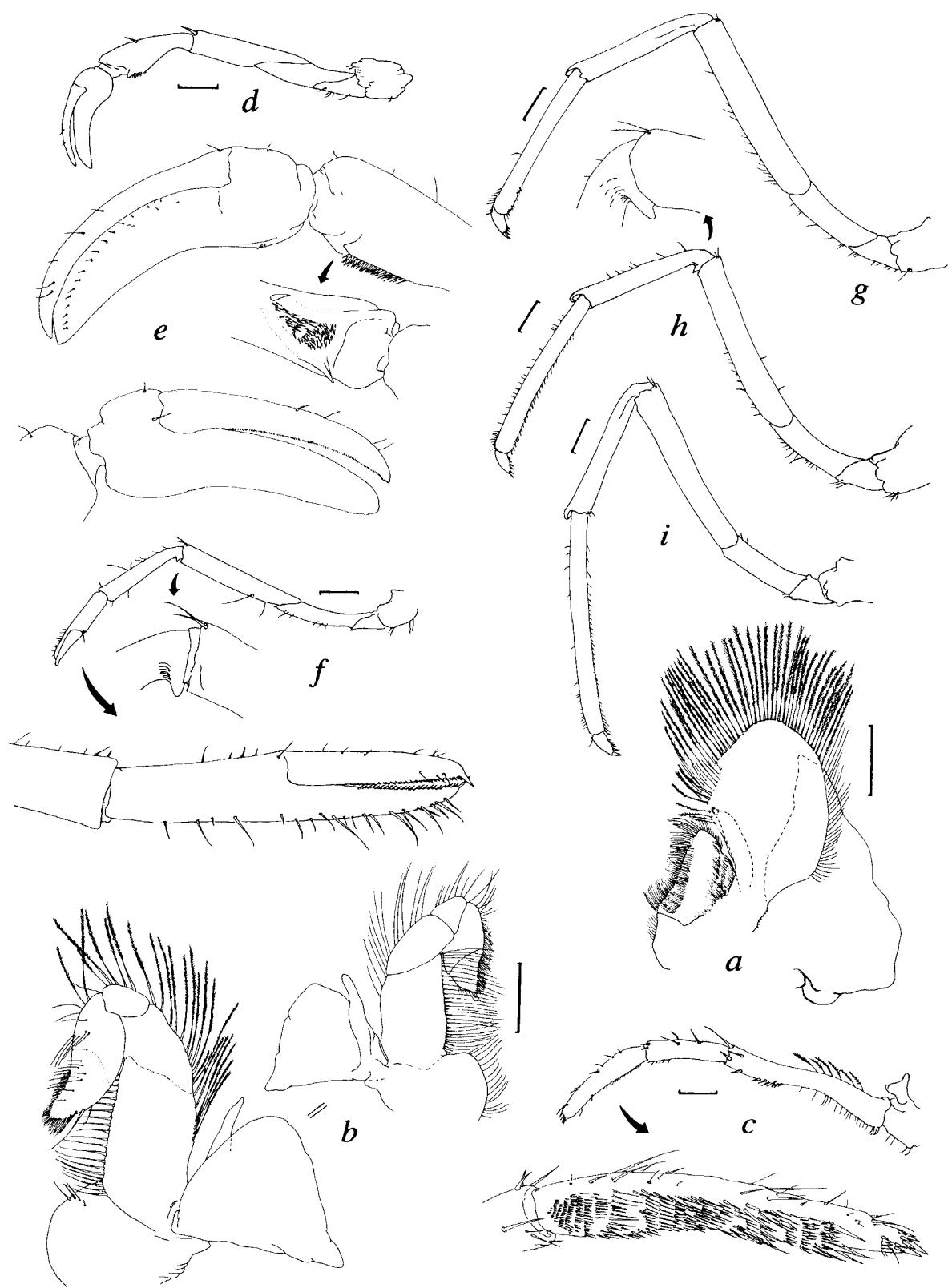
Fig. 5. *Alvinocaris leurokolos* sp. nov., female holotype: a, left mandible; b, left first maxilla; c, left second maxilla. Scale bars 1.0 mm.

with 2 acute spines, exopod reduced to small projection.

First pereopod (Fig. 6d, e) slender, robust, and chelate, with fingers curved downward and inward; propodus about 1.2 times as long as dactylus; cutting edge with row of uniform teeth set side-by-side; carpus as long as dactylus, ventrolateral surface covered with carpal brush; merus and ischium without spines.

Second pereopod (Fig. 6f) as long as first pereopod, dactylus slightly shorter than palm, cutting edge pectinate with single row of small teeth, terminal claws strong; carpus about 2.0 times longer than dactylus; no spine on ventrolateral surface of ischium.

Third to fifth pereopods generally similar in length and structure, distal portion of carpus of each with liplike projection covering proximal portion of propodus. Third pereopod (Fig. 6g) with dactylus very short, armed with 1 strong spine on ventral or flexor margin; propodus about 8 times longer than dactylus, armed with scattered setae on flexor surface; carpus about 0.9 length of propodus; merus 1.2 times length of propodus; ischium about 0.4 length of merus; merus and ischium without spines on ventral surface. Fourth pereopod (Fig. 6h) with dactylus armed with 1 strong spine on ventral or flexor margin; propodus about 8 times longer than dactylus, excluding spine of latter; carpus about 0.7 length of propodus; merus about 2.5 times longer than ischium; merus and ischium without strong ventral spines. Fifth pereopod (Fig. 6i) with dactylus armed with 1 strong spine on



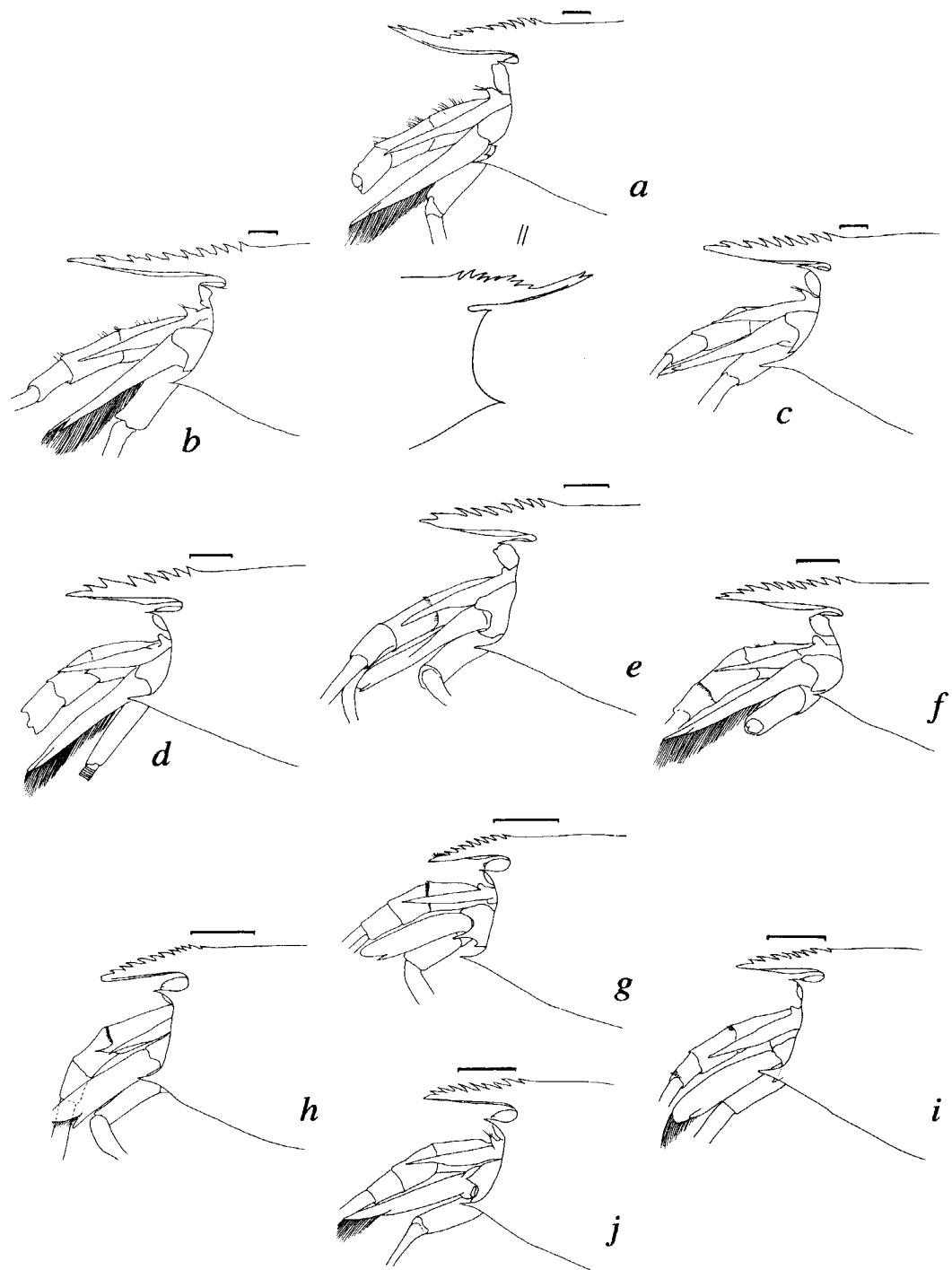


Fig. 7. *Alvinocaris leurokulos* sp. nov.: morphological variation (a-j) of anterior region in lateral aspect. Scale bars 1.0 mm.

Fig. 6. *Alvinocaris leurokulos* sp. nov., female holotype: a, left first maxilliped; b, left second maxilliped; c, left third maxilliped; d, left first pereopod; e, left first chela; f, left second pereopod; g, left third pereopod; h, left fourth pereopod; i, left fifth pereopod. Scale bars 1.0 mm.

Table 2. Armature of the merus and ischium of the posterior four pereopods of the seven known species of *Alvinocaris*.

Armature	<i>A. lusca</i>	<i>A. stactophila</i>	<i>A. markensis</i>	<i>A. muricola</i>	<i>A. longirostris</i>	<i>A. brevirostris</i>	<i>A. leurokolas</i>
Second pereopod							
Merus	0	0	0	0	0	0	0
Ischium	1	0	0	0	1	1	0
Third pereopod							
Merus	0-4	2	2	2	3	2	0
Ischium	2	2	2	2	2	2	0
Fourth pereopod							
Merus	0-4	2	2	2	3	2	0
Ischium	2	0	0	2	2	2	0
Fifth pereopod							
Merus	0	0	2	2	0	0	0
Ischium	0-2	0	2	2	0	0	0
Reference	Williams and Chace 1982	Williams 1988	Williams 1988	Williams 1988	Kikuchi and Ohta 1995	herein	herein

ventral or flexor margin, propodus about 10 times longer than dactylus, without stout spine; carpus about 0.6 length of propodus; merus about 0.8 length of propodus; merus and ischium unarmed.

Pleopods well developed. Appendix masculina of second pair of pleopods in male (allotype) armed with 6 slender spines extending beyond level of simple, slender appendix interna (Fig. 4e).

Uropods (Fig. 4d) with rami longer than telson, movable spine present on lateral ramus.

Color in life. Ivory to dull ivory white.

Variation. Morphological variations of the rostrum and anterior part of carapace are shown in Fig. 7a-j. Some adult (large) specimens (10.1-12.5 mm CL) have the rostrum curved slightly upward (Fig. 7a-c). The medium-sized specimens (8.5-9.5 mm CL) have a straight rostrum (Fig. 7d-f). Young (small) specimens (4.6-4.9 mm CL) have a short rostrum that extends slightly downward (Fig. 7g-j).

Etymology. The species name, a noun in apposition, is from the Greek "leuros" (smooth) and "kolos" (leg) because the merus and ischium of the posterior four pereopods lack spines

Remarks. As Williams (1988) suggested, species of this genus exhibit only minor differences from one another. The two new species are very closely allied to the five described species.

Alvinocaris brevitelsonis is similar to *A. lusca* (cf. Williams and Chace 1982). However, the former is easily distinguished from the latter by several characters: (1) rostrum low and curved upward; (2) length/width ratio of antennal scale 2.0; (3) chela of first pereopod robust in both sexes, palm in female of about same length as dactylus; (4) armature of merus and ischium of posterior four pereopods with different spine pattern (see Table 2).

Alvinocaris leurokolos is similar to *A. stactophila* (cf. Williams 1988). However, the new species is easily distinguished from the latter by several characters: (1) antennular peduncle reaching to (but not beyond) end of antennal scale; (2) dactylus of second maxilliped short, triangular, and length/width ratio of ischium 1.6; (3) mandibular palp long, reaching beyond incisor process; (4) posterior lobe of scaphognathite of second maxilla triangular, extremely long; (5) merus and ischium of all pereopods without acute spines on ventral surface (Table 2).

Key to Known Species of *Alvinocaris*

1. Posterior margin of telson with 3-5 pairs of terminal spines.....2
- Posterior margin of telson with 2 pairs of terminal spines3
2. Merus of fourth pereopod with 4 spines on ventrolateral margin; telson distinctly overreaching uropodal exopodite.....*A. lusca*
- Merus of fourth pereopod with 2 acute spines on ventrolateral margin; telson not reaching uropodal exopodite.....*A. brevitelsonis* sp. nov.
3. Rostrum overreaching distal margin of third segment of antennular peduncle.....*A. longirostris*
- Rostrum not reaching distal margin of third segment of antennular peduncle....4
4. Rostrum unarmed ventrally or with 1 subdistal spine on ventral margin5
- Rostrum with 4 or more spines on ventral margin6

5. Merus and ischium of third pereopod each with 2 acute spines ventrolaterally
..... *A. stactophila*
- Merus and ischium of third pereopod unarmed *A. leurokolos* sp. nov.
6. Third abdominal pleuron with posteroventral margin entire *A. markensis*
- Third abdominal pleuron with posteroventral margin obscurely serrate
..... *A. muricola*

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